Northwest Atlantic Fisheries Organization

Serial No. N918

NAFO SCR Doc. 84/IX/121

SCIENTIFIC COUNCIL MEETING - SEPTEMBER 1984

A Review of the Squid Resources of the Southeast Fisheries Region of the United States

by

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Abstract

The six species of commercially important squid in the Southeastern Fisheries Region, (Loligo pealei, Dorytheuthis plei, Lolliguncula brevis, Illex illecebrosus, I. coindeti and I. oxygonius) show separate seasonal distribution patterns and depth and temperature preferences. With the exception of Lolliguncula brevis, major concentrations are associated with topographic features which cause upwellings, such as the Charleston Bump, and resulting nutrient rich waters or nutrient laden waters around the delta of the Mississippi River. Anecdotal information from surveys and commercial fishermen support the presence of considerable stocks of squid in the Gulf of Mexico and along the Atlantic coasts of Florida and the Carolinas.

Introduction

Five species of commercially important squid occur within the southeastern fisheries region: Loligo pealei (longfin squid), Doryteuthis plei (arrow squid), Lolliguncula brevis (brief squid), Illex illecebrosus (shortfin squid) and Illex coindeti (southern shortfin squid). Because the differences between some of the species are not easily recognized, the longfin and arrow squid are generally recorded together under the name of longfin squid while the northern and southern shortfin squid are listed as shortfin squid. The brief squid is distinct. It is possible that north of Cape Canaveral only the longfin, the brief and the shortfin squid are taken in significant numbers. South of Canaveral and into the Gulf of Mexico, the distribution is more complicated as all five are found there along with another, Illex oxygonius (sharptail short fin squid).

While the shortfin and longfin species are confused in the catches and are seldom separated, the migrational patterns are different for each species as well as spawning time and abundance. There is little information on the occurrence or biology of any of the species (Voss, 1973, 1983).

Both the shortfin and the longfin squid have for many years been fished commercially in the northeast and in Canada, mainly for bait (Squires, 1957; Voss, 1973). Only in the last ten years or so has the fishery extended downward from New England into the Middle Atlantic region and the catch used for human consumption. Exploratory fishing investigations by foreign vessels, notably by Soviet, Japanese and Spanish, have mainly ended at Cape Hatteras with only a few working off the Carolinas and one to northern Florida (Long & Rathjen, 1980; Whitaker, 1980).

In the southeastern region the only source of information on commercial squid distribution and numbers has been from research vessels, resource studies on ground fish, and the records of by-catches from shrimp trawlers (Hixon et al., 1980). Increased interest in the possibility of developing a southern squid fisheries has put pressure on the various agencies to attempt to assess the southern squid stocks.

About eighteen months ago, with funds from the Gulf and South Atlantic Fisheries Development Foundation, a program was started to bring together all the known records on the presence of commercial squid in the southeastern fisheries region. Records were obtained from research and exploratory vessel reports, collection records in museums, Bureau of Land Management studies, marine laboratories along the two coasts, the NMFS computer files, shrimp and groundfish by-catch records, and others. These records were all entered into the computer bank at the University of Miami accompanied by data on date of collection, depth of capture, temperature and locality, as well as other biological data. Where possible data were also obtained on numbers or weights of specimens of each catch, sex and size. Unfortunately in almost no case were data available on kilograms per hour of trawling. Records were collected from as far back as available although most of the data were obtained within the past five years.

With over 13,000 catch records in the data bank, printouts were made on charts covering the two coasts. Records of each of the five species were printed out by month, giving 96 distribution charts. Separate printouts were made of the maximum, minimum and means of temperature and depth at capture for each species in each of the two geographic regions.

A major danger in the interpretation of the data is that they represent catches only. Thus they could represent only the fishing effort in an area and not reflect the numbers of squid present. While this is true, it is interesting to note, for instance, that on the Texas coast there are few to no records of the longfin squid during the winter months while fishing is still at a high level except in January when this species is reported from throughout the Gulf. Similarly, the mass of records around the delta of the Mississippi could relate to the activities of the bottom trawl surveys of the National Marine Fishery Service out of Pascagoula except that the same high number of records occur in months

when the groundfish survey was not in operation. It is also worth noting that there is a distinct lack of records for most species during the month of December. This is probably an artifact of stormy weather and the holiday season, perhaps both.

Results

Gulf of Mexico

Longfin squid (Loligo pealei). This northern species occurs from the Canadian Maritimes to the upper Gulf and Cuba (Voss, 1973). It is rather evenly distributed throughout the Gulf from Corpus Christi to the Dry Tortugas (Figure 1). It is a shelf species and is seldom found beyond the 200 m curve. It does not enter estuaries nor tolerate brackish water. It is the most evenly distributed around the Gulf of any of the species in almost every month of the year. In April, July, October and November (Figure 2) it was numerous in the areas to the east and west of the Mississippi delta. It is spotty with few records on the west Florida shelf, except in January. For temperatures and depths see Table 1.

Arrow squid (Doryteuthis plei). This tropical species occurs from the southern United States southward to southern Brazil (Voss, 1973). It is found in the winter months on the southeast Florida coast (Figure 3) and is virtually absent elsewhere. As the offshore waters warm in April it moves into the upper Gulf (Figure 4) but is nowhere abundant and in November and December it moves south, supporting a small fishery in the Gulf of Campeche (Solís, pers. comm.). For temperatures and depths see Table 1.

Brief squid (Lolliguncula brevis). This squid has the widest distribution of any of the commercial species, extending from Maryland to southern Brazil but always associated with estuaries (Voss, 1973). It can tolerate lower salinity levels than any other known cephalopod, living in salinities as low as 17 o/oo. It is mainly found near shore out to about the middle of the shelf.

This species is found from the Rio Grande to the Dry Tortugas (Figure 5). It too shows concentrations around the Mississippi delta in high productivity waters. It is interesting that despite the fact that the Florida Department of Natural Resources Hourglass Program was run at quarterly intervals over a two year period, the maps do not reflect that sampling pattern except for the month of September. For temperatures and depths see Table 1.

Northern and southern shortfin squid (Illex illecebrosus/coindeti). Because these two species were not recognized and reported in the records, the two species were grouped together for analysis.

There is a dearth of records for shortfin squid in the Gulf. This may be because they

are few in number but more likely it is because they inhabit the outer edge of the shelf and upper slope and thus have not been taken in the conventional Gulf fisheries. There is no apparent seasonal differences in migrations or numbers that can be read from the data. Figure 6 shows their typical distribution along the 200 m curve. In some months there are a few catch records to the east of the delta and inshore. These are probably either misidentifications or, as seems more likely from our observations, small juvenile animals. Adults seldom leave the edge of the shelf and its cooler waters. For temperatures and depths see Table 1.

Summary of the Gulf. From the above it is seen that the shelf waters of the Gulf are partitioned among the four species of squid both in temperature and depth preferences. If all of the records were from adult animals, the partitioning would be even greater. Studies by Hixon of the commercial squid of the western Gulf show these same patterns (Hixon et al., 1980).

The brief squid and the arrow squid both tolerate or prefer warmer waters. They form the populations of the inner half of the shelf, the brief squid along the shallow shores and estuaries to the inshore shrimp grounds. The arrow squid lives in the inner half of the shelf but does not enter estuaries nor favor the beach except as strays. The longfin squid, essentially a temperate and cold water species, lives in the slightly cooler and deeper waters of the outer half of the shelf. The shortfin squid is a cold water species and lives along the upper slope in waters of about $7^{o}C$ to $12^{o}C$.

The brief squid, with a wide temperature range, maintains its position throughout the year. The arrow squid, a truly tropical species, moves southward toward Mexico in the colder months. The longfin squid moves a little further offshore during the summer while the shortfin squid moves deeper to maintain its preferred temperature.

Atlantic Coast

There are far fewer records of squid catches along the Atlantic coast south of Cape Hatteras than for the Gulf. Recently, considerable new data have been obtained and are now being entered into the computer bank. On the other hand, there are perhaps more records of substantial catches on the Atlantic coast and predator stomach contents analyses indicate substantial squid stocks.

Longfin squid (Loligo pealei). There is no active fishing for the longfin squid south of Hatteras; the records on the maps from Hatteras northward represent catches made by domestic and foreign fishing vessels. The data on this species are too meager to indicate abundance or preferred fishing areas. Figure 7 for July seems to indicate a rather wide distribution.

Although there are less data for the Atlantic, this species seems to live in somewhat deeper and colder water there than in the Gulf (Table 1).

Arrow squid (Doryteuthis plei). This tropical species does not show up in the South Atlantic Bight region until the waters warm up in early summer in June (Figure 8) when they become scattered along the coast. In September they are plentiful south of Hatteras (Figure 9) but thereafter they disappear moving south when the water cools down. There are few records for this species and almost none of the records have accompanying data on temperature and depth so that these cannot be calculated. There is little doubt, however, that large numbers of the Loligo sp. records from along the coast refer to immature specimens of this species. Whitaker (pers. comm.) states that small D. plei are present in waters as far north as 33°40'N but adults move southward with warmer waters.

Brief squid (Lolliguncula brevis). This species is common along the coast and is regularly taken in the shrimp fishery. During the winter months catches are common from around Cape Canaveral and progressively farther northward to Hatteras. The presence of catches inshore and in the estuaries in October (Figure 10) may reflect inshore movement for spawning.

In the Atlantic this species seems to prefer somewhat cooler deeper water (Table 1) but this may simply reflect more offshore trawling than in the Gulf.

Shortfin squid (Illex illecebrosus/coindeti). The shortfin squid shows no particular seasonal distribution along the Atlantic coast. All of the catches are located along the 200 m curve or beyond, reflecting the trawling locations of exploratory fishing vessels. Figures 11 and 12 distinctly show the effect of the Charleston Bump and the resulting upwelling with its related high productivity. For temperatures and depths see Table 1.

Summary of the Atlantic. While the Atlantic coast has the same number of species as the Gulf, there are fewer records. Thus it is difficult to determine the relative abundance of the arrow squid and the southern shortfin squid. The first species extends its range well to the northward during the summer but is probably present in insignificant numbers during the rest of the year. The latter species is common from about Miami southward but is relatively rare beyond Cape Canaveral.

Otherwise the distribution of the remaining three species is similar to that in the Gulf of Mexico with the brief squid inshore, the longfin squid on the middle to outer shelf and the shortfin squid on the upper slope. The means for these three species both for temperature and depth correspond well both for the Gulf and the Atlantic. Temperature is the controlling factor for inshore-offshore distribution and squid distribution varies seasonally.

Discussion

Factors determining occurrence and numbers. Examination of the distribution maps show certain relationships between squid occurrence and temperature, bottom topography, and areas of high productivity. Temperature has already been discussed as have the depth ranges preferred. Bottom topography also plays an important part. The broad shallow West Florida shelf seems nonproductive as far as squid are concerned, and with only two or three exceptions, no significant numbers of squid are indicated in the region. On the other hand, the very narrow shelf along the southeast coast of Florida is not particularly good for trawling and the speed of the Florida Current may make jigging difficult. There are few records from this area probably due to the difficult terrain and current.

The most prominent feature of the edge of the shelf north of Cape Canaveral is the so-called Charleston Bump, an intrusion of the shelf into the western edge of the Gulf Stream, and a hump in the surrounding depths (Brooks & Bane, 1978; Olson et al., 1983; Bane, 1983). The Bump lies between 31° and 32°N, almost directly offshore of Charleston. This Bump causes an upwelling downstream to the northeast resulting in enriched highly productive waters being brought upward. The Bump also affects the three capes, Cape Fear, Cape Lookout and Cape Hatteras, causing additional upwelling downstream of them associated with northward traveling Gulf Stream meanders (Lee, 1984).

Upwelling colder, nutrient rich waters result in areas of high productivity which in turn afford feeding grounds for squid. Areas of upwelling or high productivity waters in the southeastern region are found on each side of the Mississippi Delta, from Cape Canaveral northward to near the Florida-Georgia border, and downstream of the Charleston Bump, Cape Fear, Cape Lookout, and Cape Hatteras. Changing upwellings of an unpredictable nature also may form along the Georgia-South Carolina region caused by wind and sea movements (Brooks & Bane, 1983).

With this brief review of the physical factors it is worthwhile to look at the evidence of population size of the various species. As there is little trawling or jigging data from commercial squid catches alone, it is necessary to rely on other types of data both positive and negative.

Catch records. The data presented in the charts are simply records of catches and are not quantitative, although an effort to provide some quantitative data will be made later. It was considered that the catch records would only represent research cruises, and, indeed, to some extent, they do. However, as reported earlier, the sampling intensity is often not reflected in squid catch records as in the Hourglass program on the Florida west coast. Similarly, the months of intensity of sampling around the delta of the Mississippi do not always coincide with exploratory trawling cruises. What is significant

about the catch records is their indication that squid are consistently found in certain areas and not in others and this should be an indication of more profitable areas for experimental commercial fishing.

Catch records of value for determining abundance may be lacking in the literature but a number are available from personal observation. Bullis (pers. comm.) observed vast quantities of the brief squid off Chandeleur Island while lift fishing for bait. From his lift net catches he considered that the brief squid formed a solid layer 15 cm thick on the bottom.

Dawson made regular seasonal trawl hauls off Grande Isle (unpublished manuscript) finding brief squid in commercial numbers over most of the year.

The shortfin squid has been taken in several large catches off the Cape Canaveral area in the last three or four years, sufficient to cause a trawler to be specially outfitted for squid fishing.

Catch records of squid as a by-product of the shrimp fisheries indicate considerable stocks although the data have been misinterpreted in recent literature (Hixon et al., 1980). Shrimp trawling is usually done at slow speed using a flat trawl on the bottom and during both day and night. Any squid caught in this fashion are purely incidental. Squid live close to the bottom only during the day and at night are diffused through the water column. They are swift swimmers and productive trawling is done with a high rise type of net at speeds twice to three times that of shrimp trawling. Thus any squid caught as a by-product of shrimp trawling probably indicate considerable stocks.

School sighting. Another type of evidence is school sighting, Bullis (pers. comm.) again has seen immense numbers of shortfin squid on the surface at night in the Gulf of Mexico.

On submersible dives off Fort Lauderdale, University of Miami scientists observed, at about 600 m, shortfin squid resting on the bottom. They were spaced about 1 m apart as far as the submersible traveled (Robins, pers. comm.). Similarly submersible dives off Bethel Shoal reported finding thousands of shortfin squid congregated on the bottom, many of them dead. This was thought to represent a mating and spawning frenzie but no egg masses were seen. There are, in fact, no hard data as to where, when, and in what manner shortfin squid breed and spawn.

Predator evidence. In the 1950's the University of Miami conducted studies on the biology of the sailfish. The biological report included studies of stomach contents and preferred food; the shortfin squid was a part of the diet but not predominantly so (Voss, 1953). In studies conducted later by both the University of Miami and the State of

Florida, within the last ten years or so the major item of sailfish diet has been the shortfin squid within the Miami-Palm Beach-Stuart area.

The initiation of longlining for swordfish in southeast Florida started studies of swordfish biology and large numbers of stomachs were saved for food studies. About 90 percent of all of the stomach contents turned out to be shortfin squid (Toll & Hess, 1981). Identifications are made from actual animals and from their beaks. Candela (pers. comm.) states that squid are found in the stomachs all year but primarily between June and November with a peak in July. At times the stomachs are filled with squid.

Areas of greatest fisheries potential. From the available data it appears that various species are plentiful in certain areas of the Gulf and South Atlantic in potential commercial quantities. To assess these potentials, however, commercial squid gear and fishing methods must be used for final proof. Continued shrimp by-catch and exploratory fishing for other types of animals will not prove the point.

Proceeding from the shore outward we perceive the following areas to have a high potential for the concerned species.

Brief squid. All of the data show that this species is widely distributed throughout the Gulf and South Atlantic and during most months of the year. It prefers areas near estuaries, bays, and coastal lagoons. During part of the year it is common along the Texas coast but the major concentrations by catch and observation are on both sides of the Mississippi Delta, off the Florida Panhandle and southwest Florida below Tampa.

On the Atlantic coast it is common from Cape Canaveral into the South Atlantic Bight. This species has not been tested in the market although it is sold in supermarkets in Texas (Hanlon, pers. comm.).

Longfin squid. This squid is distributed throughout the total area occupying the middle and outer shelf. It is often in considerable numbers from Corpus Christi to the Panhandle in the colder months of the year. It is also numerous on both sides of the Delta, where there seem to be no seasonal patterns. In the Atlantic off the Carolina capes it is common in the upwelling areas discussed before. New data just obtained from North Carolina may aid in delineating the areas of major concentrations.

Shortfin squid. This squid lives on the upper slope of the shelf in waters of around 8° to 10°C. These isotherms change constantly with wind, wave or topographically induced upwellings but it is in these areas that the major concentrations are found. From our present data there are no areas of concentration in the Gulf with the possible exceptions of the upper eastern Gulf and near the Dry Tortugas along the 200 m curve. In the Atlantic, the area between the middle keys and Palm Beach has shown large stocks supporting the swordfish fishery. Currents and bottom topography do not lend themselves

to trawling in this region.

The other major areas of potential fisheries are in the upwelling regions north of Cape Canaveral, the Charleston Bump, Cape Fear, Cape Lookout and Cape Hatteras. All need to be confirmed.

Other potential species. Two other species of squid may also have commercial prospects, particularly for the highly specialized tournament bait market. These are the orangeback squid (Ommastrephes pteropus) and the flying squid (Ommastrephes bartrami). Both of these squid are robust, heavy bodied, with thick mantles. They are very similar in appearance. Both are found offshore of the shelf edge and are attracted to lights at the ship's side. Both will take jigs but the latter has been caught primarily with fine monofilament gill nets. These two species, of which the orangeback is the commonest in the region, are highly desirable for bait due to their large size and heavy body. Prices well in excess of $6.00 per squid may be gotten for tournament fishing. A somewhat similar appearing squid (Symplectsteuthus oualaniensis) is now imported from western South America for this purpose. The orangeback squid is also excellent eating but it is doubtful if it occurs in sufficient quantities to provide a market squid.

Acknowledgments

This work was supported by a grant from the Gulf and South Atlantic Fisheries Development Foundation, R. Anderson, Executive Director. To him and the following we extend our thanks: the NMFS Pascagoula Laboratory and especially W. Nelson and E. Gutherz for critical comments, the NMFS Center Headquarters and W. Fox and D. Tidwell for assistance in obtaining NMFS data printouts; C. E. Dawson, Gulf Coast Research Laboratory, Ocean Springs, Miss., for unpublished data and manuscript; the late R. Hixon, Marine Biomedical Institute, Galveston, for critical review of the data and maps. We also thank D. Gilbert of the Dauphin Island Marine Laboratory, Miss., J.D. Whitaker of the South Carolina Wildlife and Marine Resources Department, and C.F.E. Roper and M. Sweeny, Washington, for data and the opportunity to examine collections in the Smithsonian Institution. We also thank H.R. Bullis, Miami, for numerous observations and comments based upon his years of exploratory fisheries in the Gulf of Mexico. This is a Scientific Contribution from the Rosenstiel School of Marine and Atmospheric Science, University of Miami. It also constitutes a scientific report to the Gulf and South Atlantic Fisheries Development Foundation.

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Table 1. Ranges and means of depth (in meters) and temperature (in °C) of squid by species in the Gulf of Mexico and South Atlantic.

	Depth		Temperature	
	G. Mexico	Atlantic	G. Mexico	Atlantic
Lolliguncula brevis	1- 26-325	5- 76-278	12-22-29	14-19-26
Doryteuthis plei*	11- 43-136	--- --- ---	17-23-28	-- -- --
Loligo pealei	9- 56-298	23-105-274	10-20-26	8-10-13
Illex spp.	281-314-517	171-367-597	10-11-13	7-10-14

* Insufficient depth and temperature data for this species in the Atlantic.

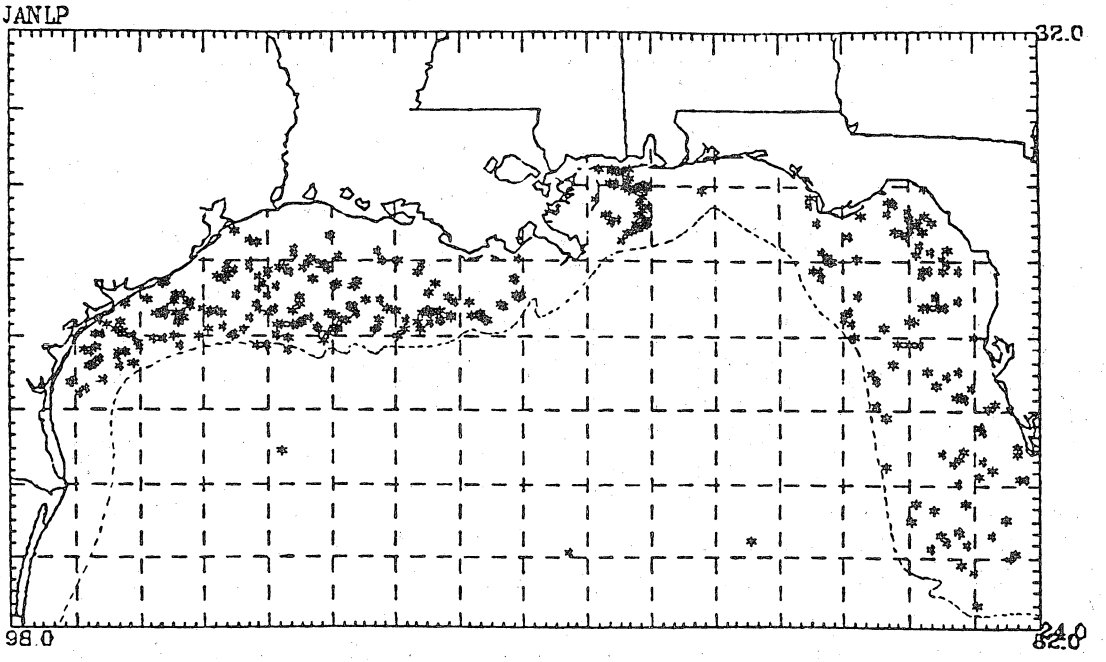

Figure 1. Distribution of Loligo pealei in the Gulf of Mexico during the winter months.

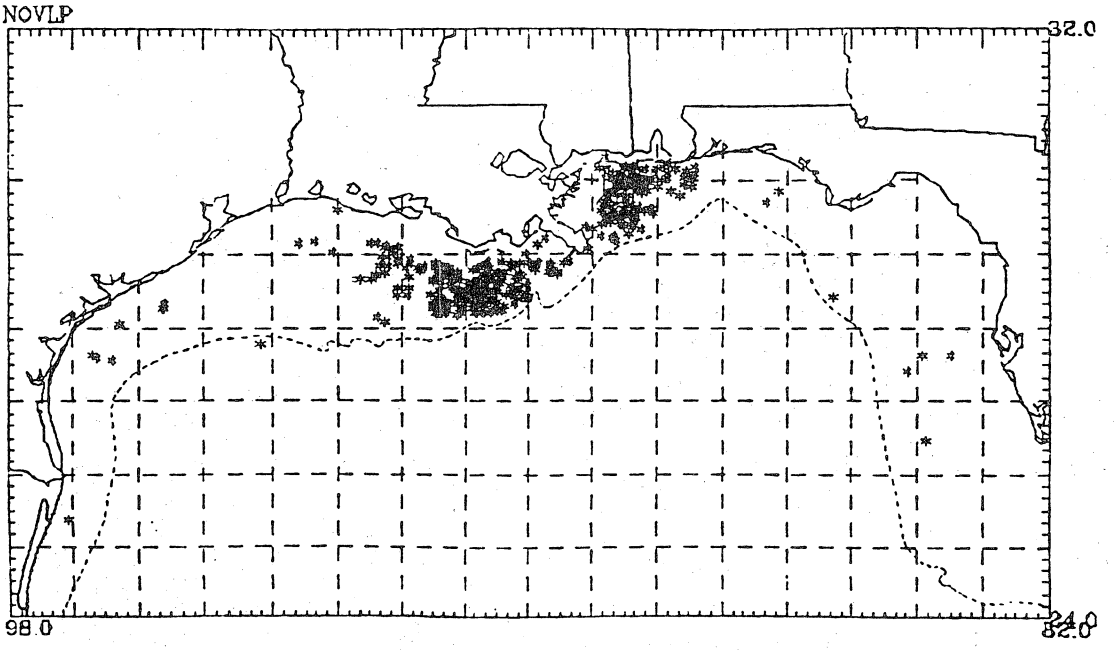

Figure 2. Distribution of Loligo pealei in the Gulf of Mexico during summer and fall.

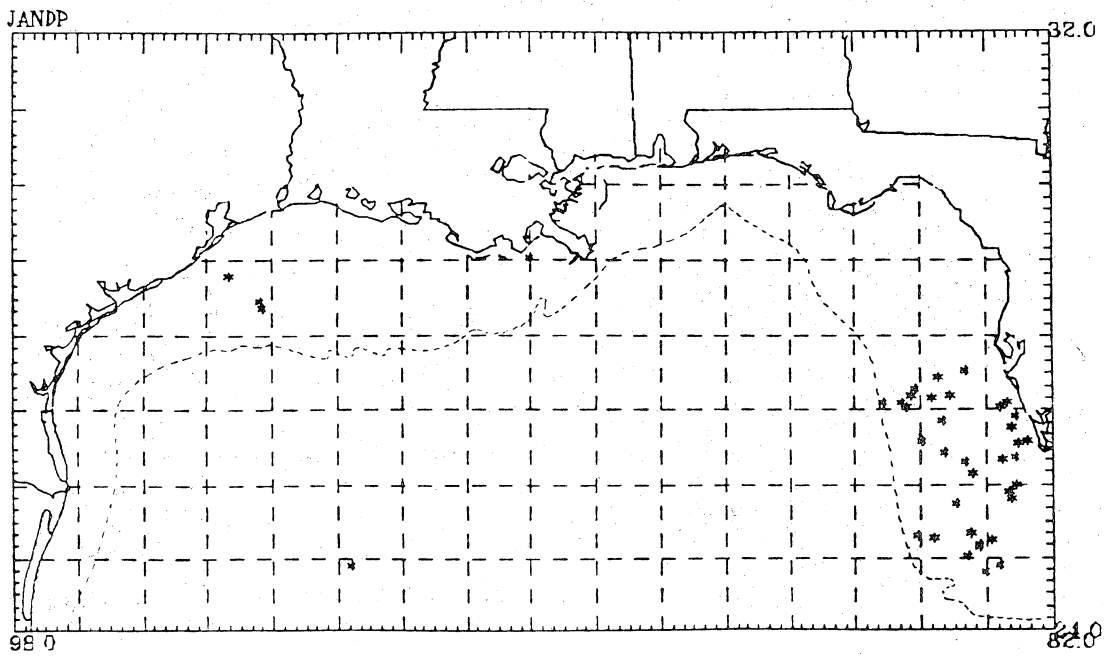

Figure 3. Distribution of Doryteuthis plei in the Gulf of Mexico during the winter.

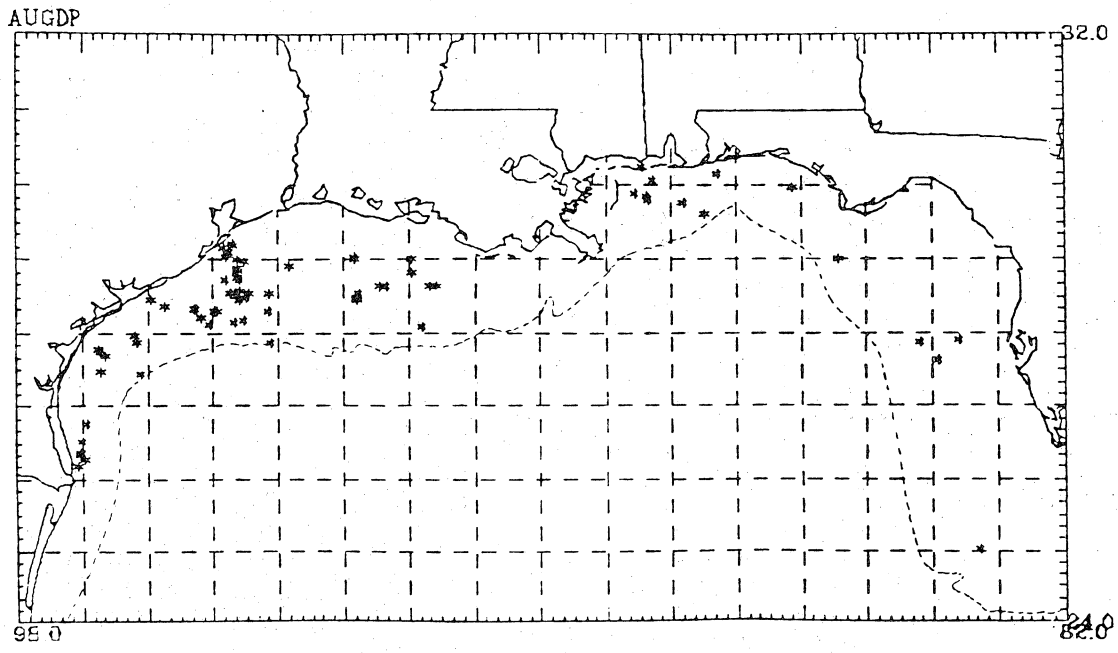

Figure 4. Distribution of Doryteuthis plei in the Gulf of Mexico in spring and summer.

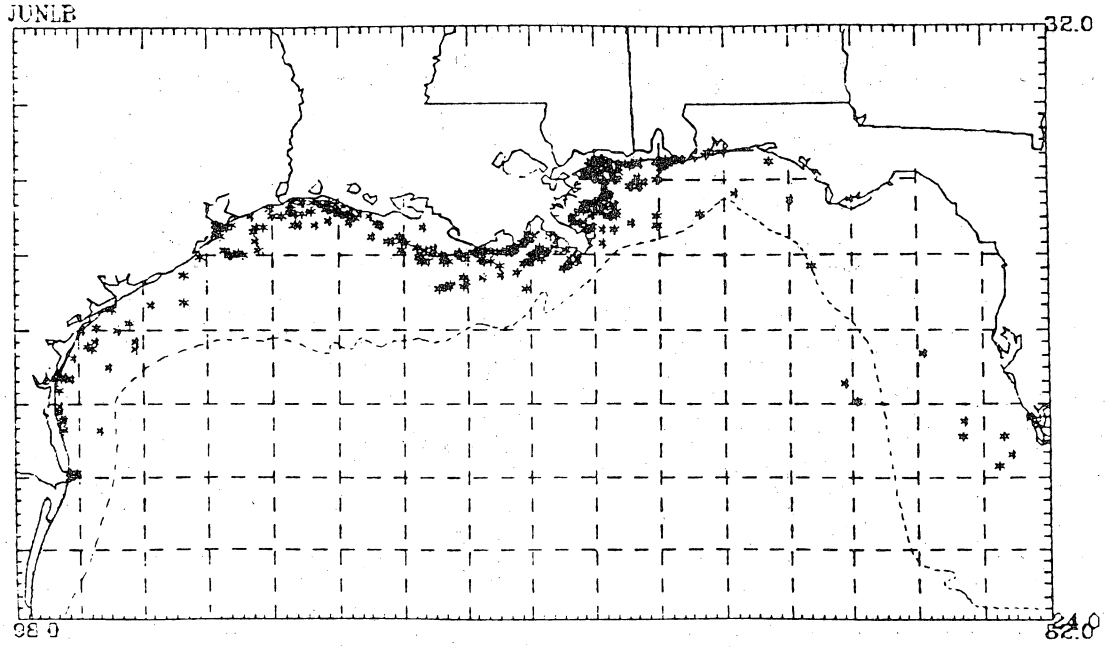

Figure 5. Distribution of Lolliguncula brevis in the Gulf of Mexico throughout the year.

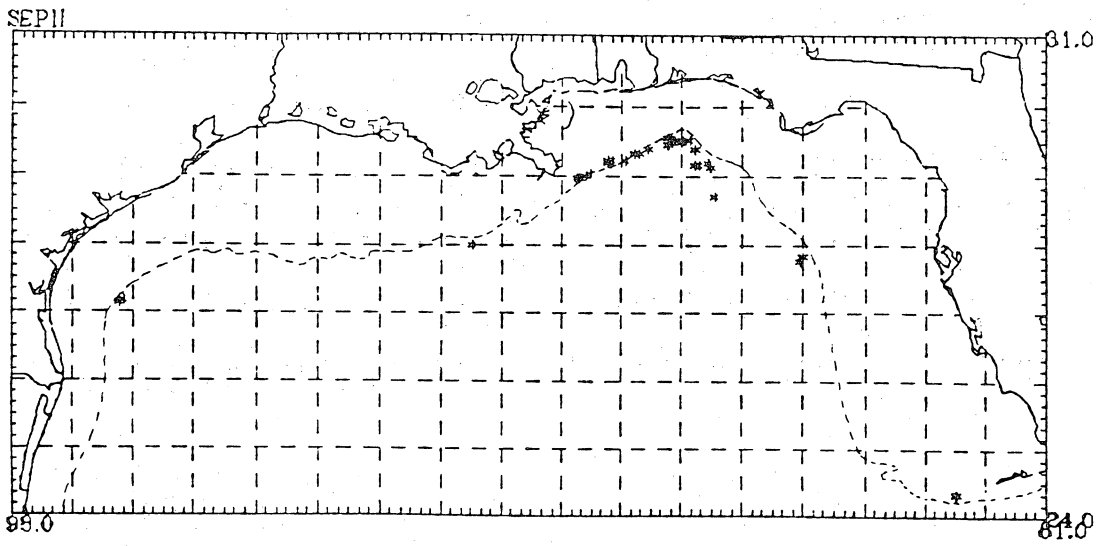

Figure 6. Distribution of Illex spp. in the Gulf of Mexico along the 200 m curve.

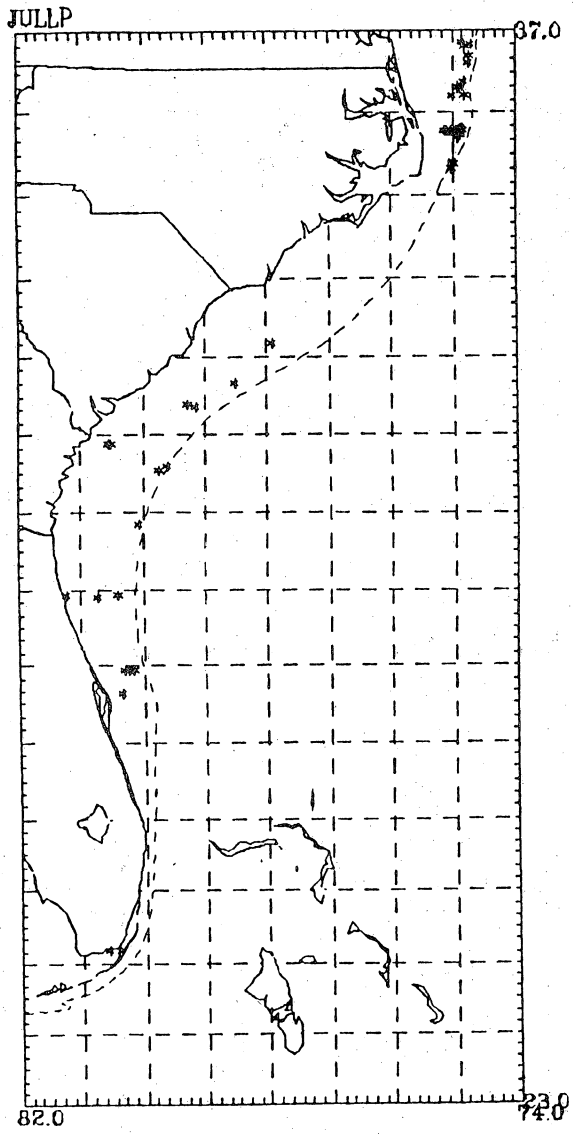

Figure 7. Distribution of Loligo pealei along the southeast Atlantic coast in July.

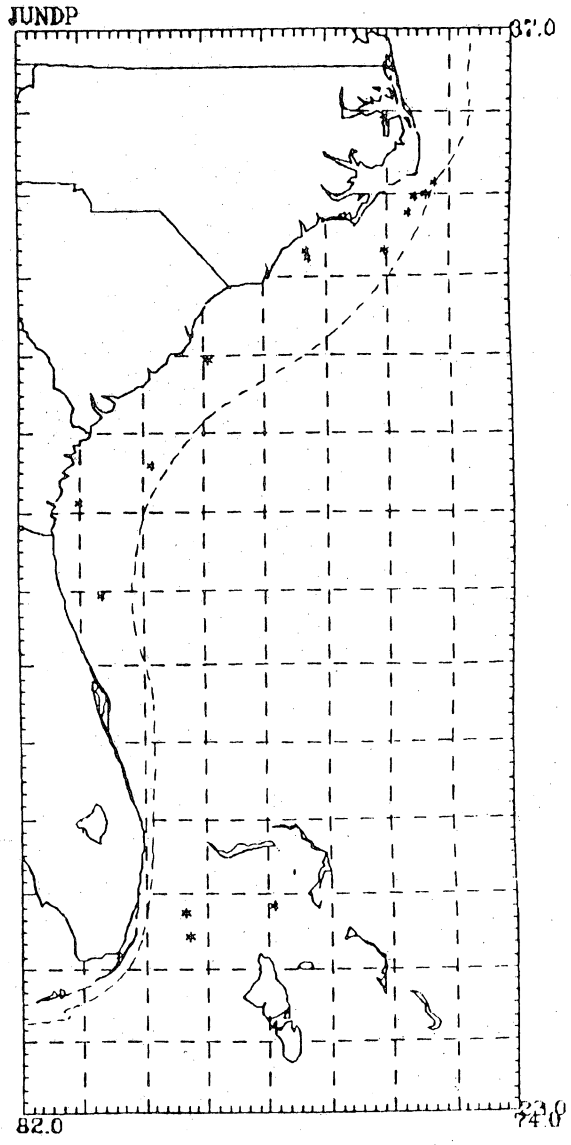

Figure 8. Distribution of Doryteuthis plei along the southeast Atlantic coast in June.

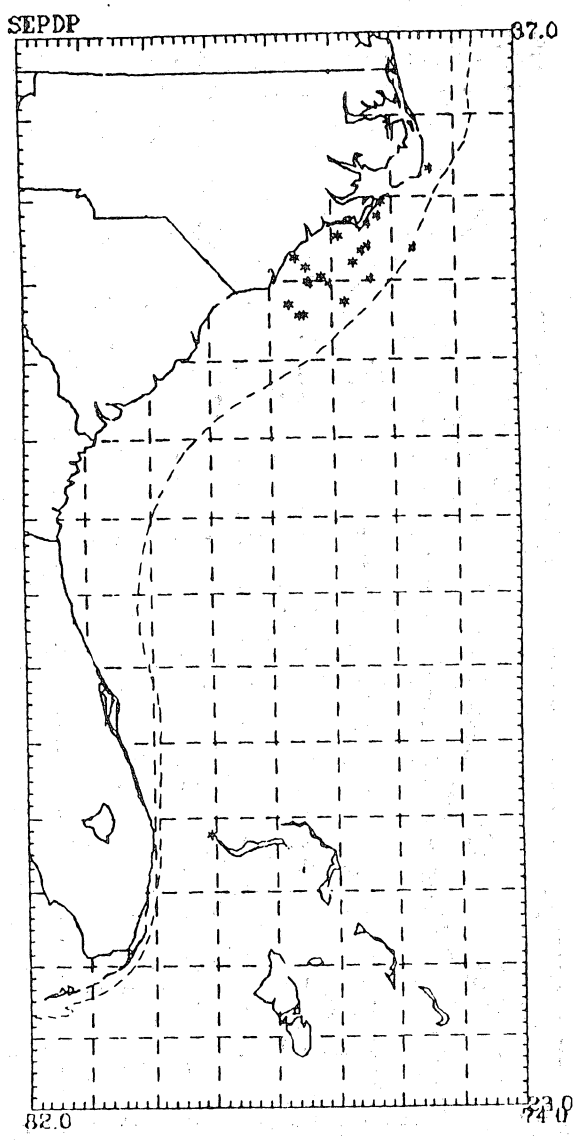

Figure 9. Distribution of Doryteuthis plei along the southeast Atlantic coast in September.

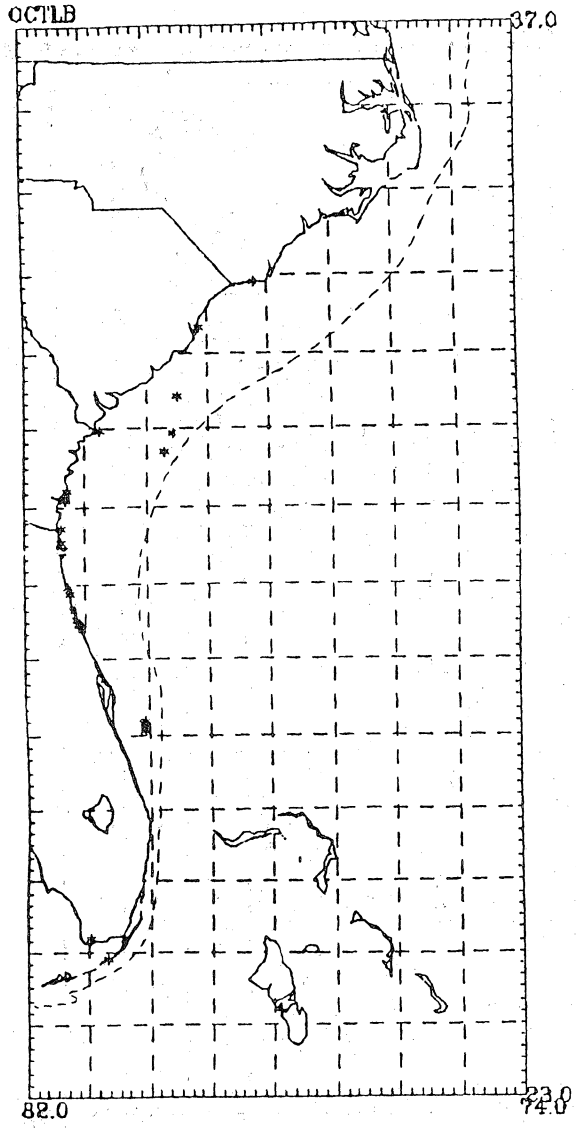

Figure 10. Distribution of Lolliguncula brevis along the southeast Atlantic coast in October.

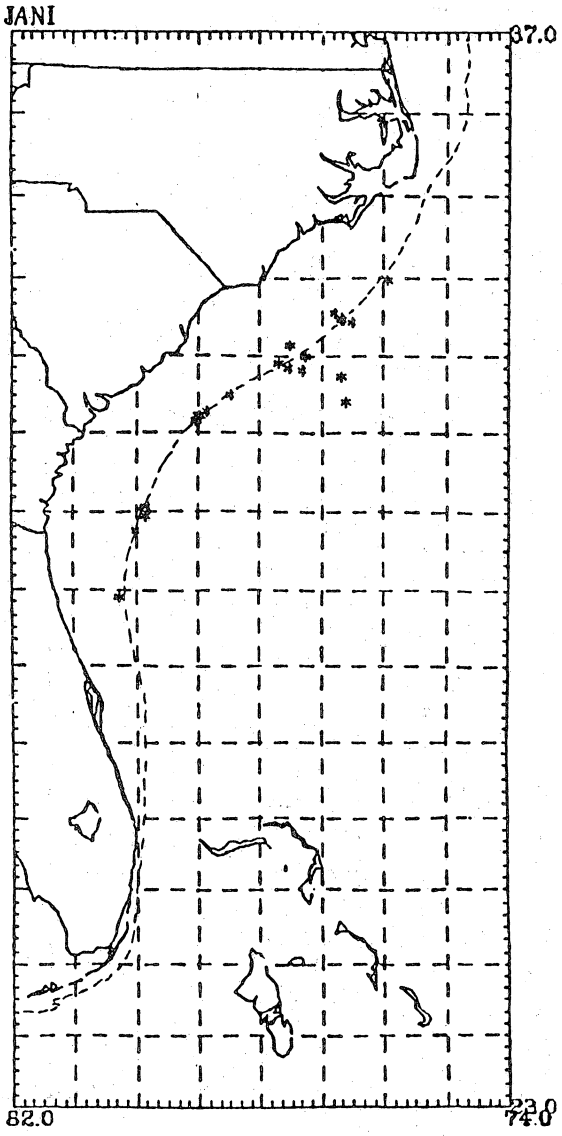

Figure 11. Distribution of Illex spp. along the southeast Atlantic coast in January.

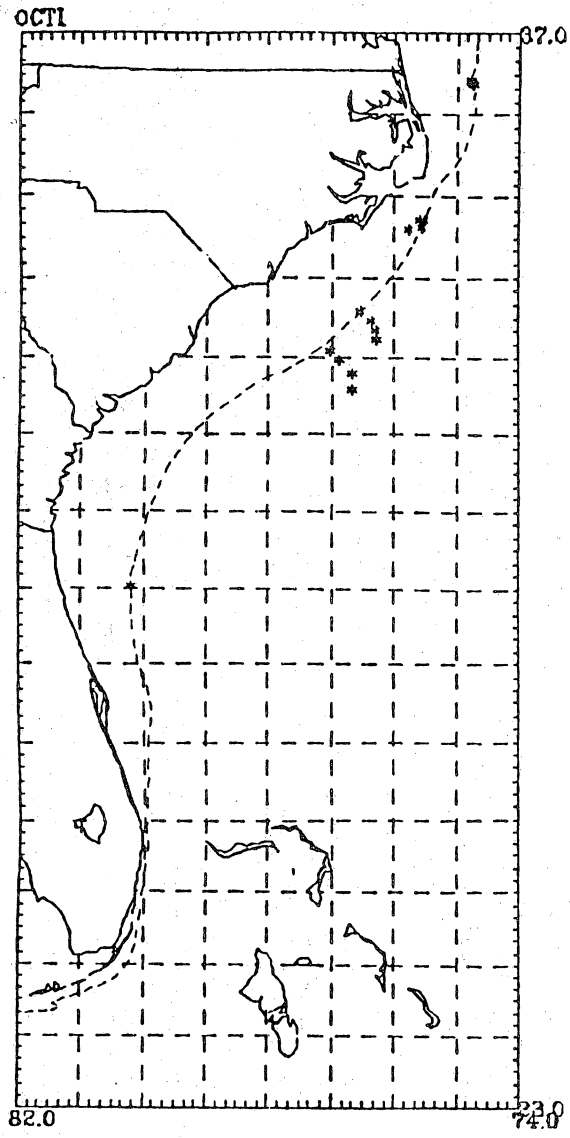

Figure 12. Distribution of Illex spp. along the southeast Atlantic coast in October.